Depleted Uranium (DU) Munitions

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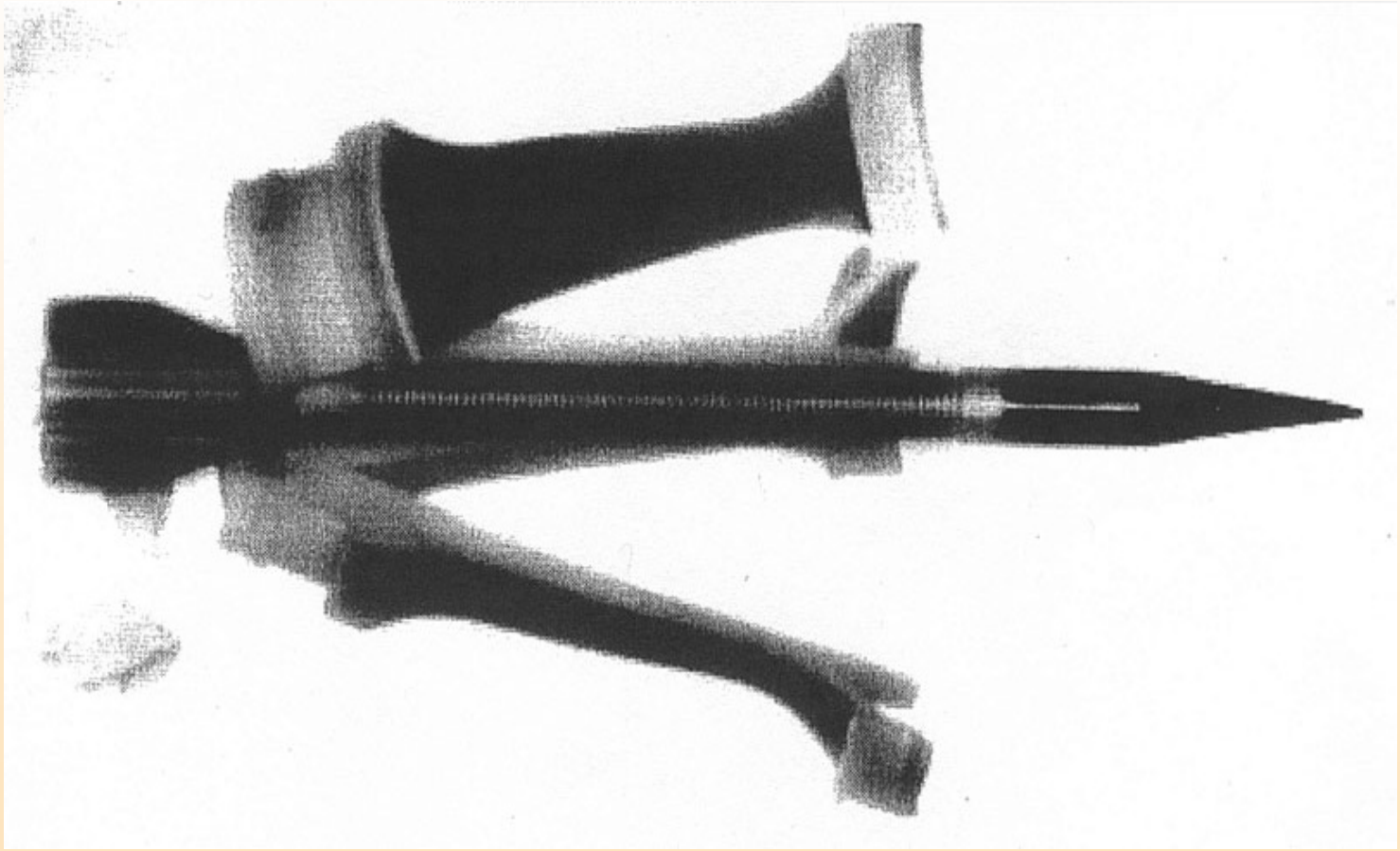
OSD/DOT&E/CS



Depleted Uranium (DU) Munitions

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  - Physical/chemical properties,
  - Medical diagnosis,
  - Detection,
  - Treatment, and
  - Epidemiological findings among veterans

Depleted Uranium (DU) Munitions

- Due to its extreme density (1.7 times the density of lead), DU is used as:
  - The armor plating,
  - Penetrator kinetic energy munitions for its mass and pyrophoric properties under conditions of extreme temperature and pressure.

Depleted Uranium (DU) Munitions

- The naturally occurring uranium consists primarily of three nuclides according to the following percentages (by weight):

  - ^{238}U (99.283%),
  - ^{235}U (0.711%),
  - ^{234}U (0.005%).

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For nuclear power generation and nuclear weapons, “enriched uranium” contains greater than 0.711% ^{235}U.

Depleted Uranium (DU) Munitions

- "Depleted uranium" contains less than 0.711% ^{235}U (by definition).
- DU is produced as a by-product of the enrichment process for nuclear reactor-grade or nuclear weapon-grade uranium,
- Generally consists of less than 0.3% ^{235}U, and hence is
- Less than half as radioactive as natural uranium

Depleted Uranium (DU) Munitions

DU is radioactive and produces:

- **Alpha particle,**
- **Beta particle,**
- **Gamma ray (small).**

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The alpha particle taken inside the body in large doses is hazardous producing:

- **Cell damage and cancer,**
- **Clothing and skin protects from external alpha exposure.**

Note: Lung cancer is well documented.

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- The beta particle is hazardous to the skin and the lens of the eyes,
- Safety eyeglasses protect from beta particle,
- Leader gloves protect your hands.

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- The gamma radiation: An Electromagnetic radiation of high energy that penetrates through the body,
- Only dense metal such as lead can shield the radiation.
- Because DU is depleted uranium, energy levels are very small…”Weakly radioactive”

Depleted Uranium (DU) Munitions

- DU is chemically toxic:
  - –Due to heavy metal like lead,
  - –The target organ is the kidney and bone.

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- Urine samples containing uranium are mutagenic as determined by the Ames test.
- The cultured human stem bone cell line with DU also transformed the cells to become carcinogenic.

Depleted Uranium (DU) Munitions

- **The following ammunition contains DU cartridge penetrators:**

DODIC	MODEL	SIZE
A675	MK149	20mm
A676	MK149	20mm
A986	M919	25mm
A983	PGU-20	25mm
A979	PGU-20	25mm
B102	PGU-14	30mm
B103	PGU-14	30mm
B117	PGU-14	30mm
B128	PGU-14	30mm
C523	M774	105mm
C524	M833	105mm
C543	M900	105mm
C783	M827	120mm (Not fielded)
C786	M829	120mm
C380	M829A1	120mm
C792	M829A2	120mm

Depleted Uranium (DU) Munitions

The AMSOS-SF (Army Materiel Subordinate Operation Support-Safety) for the U.S. Army Operations Support Command (OSC):

a. Licensed by Nuclear Regulatory Commission (NRC),

b. Manages the DU munitions for:

Inspecting, storing, handling, issuing, transporting, uploading, minor maintenance, or using DU munitions at the U.S. Army installations.

Depleted Uranium (DU) Munitions.

- This license does not cover testing, firing, or production of DU munitions.
- If the DU contents are accidentally released to the environment, perform a swipe test on samples taken from DU munitions.
- Contact AMSOS-SF immediately if radioactivity exceeds:
  - 500 DPM for alpha or
  - 100 DPM beta/gamma.

Depleted Uranium (DU) Munitions

Emerging Medical Management Issues:

- During the Persian Gulf War, a number of allied military personnel internalized DU fragments as a result of several friendly fire incidents (only the allied forces possessed DU munitions).
- The three major routes of human exposure to DU are:
  a. Wounding by shrapnel,
  b. Inhalation (lungs and thoracic lymph nodes),
  c. Ingestion (most among children playing and eating contaminated soil and contaminated drinking water and food in the community).

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1. At that time, existing DoD fragments removal guidelines indicated that shrapnel be remained in place unless they cause future health threat.

2. Because DU is still radioactive, studies were performed in rats with embedded DU fragments.

3. Indicated that uranium would be solubilized and redistribute to various tissues as early as one day after implantation.

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4. As expected, the highest uranium concentrations were in kidneys and bone.

5. Other tissues also showed significantly higher levels.

6. Urine samples containing uranium showed mutagenic as determined by the Ames test.

7. The cultured human stem bone cell line with DU also transformed the cells to become carcinogenic.

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- 8. Because of these findings, there are proposed changes in the DU shrapnel removal policy. For example, it is now advised that DU fragments greater than 1 cm be removed unless the medical risk is determined to be too grave.
- 9. The other significant changes include a procedure to detect the presence of DU in the metal fragments and treatment guidelines.

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- **Laboratory Diagnosis: Procedures to detect the presence of subcutaneous DU:**
  - **a. X-ray fluorescence Method: ^{57}Co to excite the uranium to produce X-rays (< 3-4 cm deep).**
  - **b. Differential attenuation Method: A whole body gamma-ray counter with hyper-pure germanium detectors.**
  - **c. Spectrophotometric Method: In vitro nitric acid extraction and Br-PADAP chelating color development read at 578 nm.**

Depleted Uranium (DU) Munitions

- **Epidemiological Studies After Wars in Gulf and Balkans:**
  - **Fired about 340 tons of DU munitions during the 1991 Gulf War;**
  - **Fired about 11 tons in the Balkans in 1990;**
  - **About 70-80% of all DU munitions penetrators remain buried in the soil;**

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- Emerging environmental concerns include:
  - A significant exposure to DU among children playing in the impact sites by ingesting heavily-contaminated soil,
  - Slow leaching of DU in local water supplies over years,
  - Consuming DU contaminated food sources (animals and plants).

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- **Heavy metal toxicity issues:**
  - **Occupational exposure limit: 3 mg uranium/g kidney;**
  - **Kidney failure/dysfunction with a few days if large intake of DU (>50 mg uranium/g kidney);**
  - **The estimated DU intake for most soldiers on the battlefield: 0.1 mg uranium/g kidney**
  - **No reported case of acute kidney failure among soldiers, but long-term effect is unknown (The Royal Society Report, March 2002).**

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- **Radiation Health Effects:**
  - Inhalation exposure (major effect): Lungs and thoracic lymph nodes;
  - The lifetime risk of lung cancer in general population: 1:250 for non-smoker, and 1:6 for cigarette smokers;
  - Soldiers on battlefield: Estimated lung cancer: <1:40,000 (The Royal Society Report, March 2002)
  - The most heavily exposed soldier: Estimated lung cancer for the most worst-case to be about 1:15, but more likely 1:1,000 surviving in a struck tank (The Royal Society Report, March 2002);

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Radiation Health Effects continue:

- DU can be deposited in bone causing DNA damage by the effects of the alpha particles;
- A large inhalation of dust (without radiations): Long-term respiratory effects (Lung fibrosis, in addition to risk of lung cancer).
- Immune deficiency: Negligible effect (The Royal Society Report, March 2002);
- An extra risk of death from leukemia and other cancers: Insignificant and much lower than that of lung cancer (The Royal Society Report, March 2002).

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- **Future Studies/Recommendations:**

  a. Monitoring of kidney function and urine uranium levels among children, peacekeepers, and inhabitants.

  b. Epidemiological monitoring of cancer incidents among soldiers surviving during friendly fire and soldiers working for protracted periods in heavily contaminated vehicles, including urine uranium testing, kidney function tests, and neurological evaluations.

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Future Studies/Recommendations:

c. Heavily contaminated soil should be removed if the area is to be populated with civilians.

d. Long-term annual water and milk sampling for DU levels in the impact site.

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DU Munitions Capstone Test Firing:

1. **June of 2001 at ATC/APG in the "Superbox", DU sampling in support of the M1A2 Abrams live-fire vulnerability test was performed. The purpose of this test firing is to:**

   - **Sample inside the crew compartment of a vehicle following a DU munition firing,**
   - **Determine the DU surface contamination levels in and on the vehicle after impact with a DU munition.**

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2. This DU Capstone is designed to specifically evaluate:

- **The aerosol concentration,**
- **Particle size distribution, and**
- **contamination levels at the time of impact associated with the interaction between DU penetrators and armored vehicles.**

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- For inhalation exposure, a larger rapidly dissolving uranium was observed in the airborne material than in the settled material (RC Scripsick et al, Govt Reports Announcements & Index, Issue 02, 1985).
- This indicates to me that the size of particle becomes important for aerosolization during inhalation.